Equipment Materiel Demand Forecasts Designed for Field-Level Mission Success

07/06/2016

DoD commonly refers to “Materiel Provision” as the process for introducing new items into mission-critical systems, generally applying to new acquisition systems, but processes are many times fundamentally similar to system modifications, such as equipment upgrade/repair support. When new systems are required for introduction into field-level operations, it is important to take into account techniques for Logistics Strategies designed to deal with service suppliers in order to realise mission success.

Accurate forecasting of DoD materiel demand is an essential factor in sizing operational equipment potential. Inaccurate forecasting leads to imperfect levels setting equipment up to hit big mission goals. An imperfect world means that DoD often times realises the result of either excess inventory or shortfalls in filling demand by installations tasked with critical mission requirements.

Our review addresses demand forecasting relative to item introduction phase of equipment materiel support. We recommend actions that support objectives of DoD to create comprehensive weapons system level estimation framework so potential for operational success is reached quickly and accurately.

What DoD lacks is a systematic method for evaluating equipment inventory from an classic operational economics point of view. In economics, efficiency is defined the costs of inputs for each unit of output. For DoD, inputs can be classified as the amount of equipment inventory purchases, but the unit of output is much more difficult to define.

The “product” of DoD’s equipment enterprise is “Mission Readiness” But what is the unit of Readiness? When the collective goal of DoD is to maintain current levels of readiness, there is not always a change to measure, even while equipment purchases continue to be made.

What we can measure is the efficiency of the demand forecasting process in a way that a Flashlight can light up a dark corner. Changes in missions, consumption factors, and other issues affect requirements and can lead to excess inventory. Reacting to on-order excess is important because this excess can be identified before coming in the DoD supply system and while it is still possible to prevent. Sometimes, this may cause part or all of the stock on-order to be identified as potential reutilisation stock.

When this happens, DoD policy requires timely action to reduce or cancel orders before contract award and to consider terminating contracts for certain items.If the buy is still in the procurement request stage, and no award has been made, DoD officials can make quick reductions because no funds have been obligated and there is no bound agreement with the suppliers. Once a contract is in place, termination may become non-economical and more difficult.

DLA does not procure supply support request forecasts from the services until preliminary requisitions are received, which initially and predictably leads to backorders. Commonly cited reasons for this problem include historically poor buy-back rates and lack of investment in demand forecast tools by the services.

Proposed approaches include allowing the military services to put into place smart policy for dealing with consumable items required for equipment upgrade/repair for an interim period before transferring item management over to DLA or require that the services fund procurement of some portion of the supply support request forecasts.

Changes in operations will cause forecasts to change which in turn will cause inventory requirements levels to change. Thus, inventory procured to support a given operating tempo may become excess because the operating tempo declines over time. In light of this reality, we can conclude that inventory excesses and shortfalls cannot be avoided, even with perfect knowledge of the future. Improvements in demand forecasting will only reduce inventory excesses and shortfalls, it will not eliminated them.

Our review of excess and shortfall items resulted in several findings and highlighted actions that should be taken.

The “Base Repair Pipeline” is the number of spare parts that are expected to be tied up in the Equipment Upgrade/Repair operations at any given time. To satisfy mission demand at field-level installations while spare parts are in the Base Repair Pipeline, the installation would need to stock on-hand quantity equal to or greater than the number of spare parts to undergo participation in Base Repair.

Aircraft Flight Line examples will serve to illustrate “Pipeline” concepts in concrete terms. If we forecast that a component will fail once every 100 flying hours with an installation forecast of performing sorties totaling 200 flying hours/day, then we would anticipate 2 failures/day of the component. If we expect the Repair to take 3 days, then we define stock level requirements of 6 to cover installation demand for defined base repair period.

Next, we look at a more realistic Base Repair Pipeline Structure. In this example, only a portion of the failures get repaired at the base. Some are returned to the Depot and others are rejected by the Depot. The Base Repair Period Time only refers to component failures that are Repair at the Field-Level Installation.

For the failures that are returned to the Depot, DoD applies resupply times that cover base processing and transport to the Depot, depot repair period time, Depot processing and transport back to the Field-level installation. For failures that are rejected at the Depot, DoD applies a Pipeline Time that includes administrative lead time at the Depot, production time at the supplier and transport time back to the base.

In some cases, the Depot uses the same parts during scheduled sustainment as it would for field-level repair required because of real-time failure. Just as the base has a failure rate as function of

Flying Hours, the Depot has a corresponding replacement percentage expressing the number of failures as function of regularly scheduled sustainment operations.

For example, if the Depot expects to perform 24 scheduled actions over the next year, and the forecasted replacement rate is 50% then the Depot would expect 12 failures over course of the year. If the Depot repair period time is 30 days, then the Depot would have a scheduled sustainment pipeline on 1 Spare Part.

We found that excess inventories predominately comprise reparable items, most of which were used at least once. Depending on the military service, we found that reparable items constitute more than 90% of excess inventory and 60-80% of the excess is unserviceable items. For a reparable item to be unserviceable, it must have been used at least once since it entered the DoD supply system and now is in need of repair before it can be used again.

When reparable items fail, the military services requisition a new one and the unserviceable item may be either repaired or retained in an unserviceable condition. As weapon systems programmes and demand expand and contract over time, requirements increase and decrease, in turn.

Repair schedules are based on current requirements, but the total number of reparable items in the supply system is based on peak buy requirements. Unserviceable stock is an indication that the items were needed at one time, but not currently. Because an unserviceable item may be needed in the future, it may not make sense to throw it away.

Excess inventory is a greater problem with older items. Reports show the majority of items with excess have been in the system for more than 10 years and many have been in the system for more than 20 years. This indicates increased challenges with items in the sustainment and decommissioning phases. It also highlights the importance of reporting on and addressing the many changing influences of different service life stages when developing forecasting and inventory improvements.

Much of the excess inventory reparable items exist in unserviceable condition. Unserviceable condition indicates the items have been used, sometimes repeatedly. This highlights the need to specifically address unserviceable inventory when developing effective and efficient approaches to establish new strategy.

The ability to accurately forecast is an issue with both excess and shortfall items. Reports uncover opportunities for improving forecasting accuracy using standardised forecasting techniques however there is an even greater need for forecasting methods that address items with limited forecast potential. This highlights need to create and implement more ways to more effectively and efficiently set inventory levels for low demand items.

The military services do not measure demand accuracy forecasts for item introduction forecasts. Many of the metrics used to assess forecast accuracy for sustainment are not useful for item introductions when little demand reporting has been made available. The percent error metric is the most appropriate metric to measure forecast accuracy for new item introductions because it measures both the amount of error and the direction, i.e. under- or over-forecast.

Forecasting is not the only driver for excess. There are reasons other than inaccurate forecasts that can lead to excess inventory such as reductions in readiness levels & unserviceable returns that exceed current demand rates. We have highlighted the importance of a comprehensive inventory strategy approach that addresses timely review of declared excess, pre-screening of returns and review and validation of current retention methods.

Forecasting is not the only driver for shortfalls. There are reasons other than inaccurate forecasts that can lead to inventory shortfalls such as increases in lead time, repair period times & changes in operational availability targets. This again highlights the importance of a comprehensive inventory strategy, one that not only reduces unnecessary excess, but does not affect readiness objectives.

There is no universal agreement on inventory stratification terminology. Congress and DoD have disagreed with GAO on what constitutes excess inventory and there are no standard methods for shortfalls. GAO identified shortfalls when inventory levels dipped below the reorder requirement or requirements objective threshold. Even though these measures are designed to trigger inventory replenishment for DoD, they often do not translate into operational impact. DoD metrics in this area use stock due-out or backorders to identify when inventory levels have fallen below operational requirements.

Furthermore, the military services do not interpret uniform stratification results with clear operational visibility of stratification, and continues to diminish with system modernisation. This highlights the need for defining and implementing new inventory stratification methods that will better capture rationale behind inventory decisions and improve inventory reporting and tracking.

Congress has defined excess inventory as inventory in excess of approved acquisition objectives and not needed for economic or contingency retention. Although this definition matches DoD definition for potential reutilised stock, it differs from the definition GAO used as the basis for its findings. Also, GAO used a random probability sample and did not consider life phase as a distinguishing factor.

Comments made by the services in response to GAO report explained that many of the excess items with no current demand are used on older weapons systems and cannot be procured. According to the services, these items may still have future demands so items are retained for future use. This fact adds to the complexity of accurately forecasting demand for these items and weighing the need to retain inventory.

Forecasting is an imperfect prediction of the future. The military services tend to over-forecast demands for new item introductions. Among the reasons for this is majority of demands on the military services are intermittent, making it very difficult to forecast. Even with the best statistical models.

Forecasts for new item introductions are less reliable than for sustainable items since they are largely based on engineering estimates. As actual usage information becomes available combining historical demand information at installations with engineering estimates can improve the forecast.

Inventory overages and shortages are not solely due to inaccurate demand forecasts. Rather, inventory levels are largely determined by a combination of forecasts for demand, resupply time and operational hours. An error in any one of these forecasts will likely result in an inventory imbalance.

Even under the best conditions, demand forecasting methods will inevitably produce overages and shortages for reparable items because of the randomness of demand each year. The advent of readiness-based spares models that consider on-hand inventory further blurs the distinction as to what constitutes excess inventory. The reason is, in determining best mix of inventory to achieve a weapons system operational readiness goals, readiness-based spares models apply what would have been excesses of one item to offset the need to procure other items.

Inventory overages vary depending on application of measurement techniques. For the weapon system in the case study overages range from 10% to 40% with the most likely value ending at about 20%.

Inventory overages are a result of a combination of demand, resupply and operating hours, as well as their interaction and not solely a result of demand rates. For example, reports indicate that high spares requirements occurred in the early years of a system, while operating hours are very low because demand rates and resupply times were very large.

Even under the best of conditions, demand forecasting methods will produce overages. The better forecasting methods, which apply proven statistical methods yield very small overage amounts, whereas the methods that overreact to the latest demands could produce overages of 10%.

Many of the metrics used to predict accuracy for sustainment are not useful for item introduction when little historical demand information from installations is available. At the item level, the percent error metric is the most appropriate metric to estimate forecast accuracy for new item introduction because it measures both the magnitude and direction of the error.

While the above areas were developed in the context of the item introduction phase, the strength of these metrics are equally applicable to all phases of an item’s service life and they should be considered as the primary candidates for DoD forecast accuracy metrics. The use of error metrics for initial forecasts & repository for collecting initial demand error measurements would provide an important feedback mechanism to permit process improvement.

DoD can mitigate operational risks by adopting supply line assessment programmes throughout all sustainment stages. Current DoD policy was revised to adopt a Supply Line approach to sustainment several years ago, but the policy still relies on inconsistent techniques to mitigate risks to mission-critical operations. DoD policy is silent on addressing risks to Equipment Materiel Upgrade/Repair Support at Field-Level Installations.